Title: An Approach for Performance Based Glove Mobility Requirements

Authors: Lindsay Aitchison, Elizabeth Benson, Scott England

The Space Suit Assembly (SSA) Development Team at NASA Johnson Space Center has invested heavily in the advancement of rear-entry planetary exploration suit design but largely deferred development of extravehicular activity (EVA) glove designs, and accepted the risk of using the current flight gloves, Phase VI, for exploration missions. However, as design reference missions mature, the risks of using heritage hardware have highlighted the need for developing robust new glove technologies. To address the technology gap, the NASA Space Technology Mission Directorate's Game-Changing Development Program provided start-up funding for the High Performance EVA Glove (HPEG) Element as part of the Next Generation Life Support (NGLS) Project in the falloff 2013. The overarching goal of the HPEG Element is to develop a robust glove design that increases human performance during EVA and creates pathway for implementation of emergent technologies, with specific aims of increasing pressurized mobility to 60% of barehanded capability, increasing the durability in on-pristine environments, and decreasing the potential of gloves to cause injury during use. The HPEG Element focused initial efforts on developing quantifiable and repeatable methodologies for assessing glove performance with respect to mobility, injury potential, thermal conductivity, and abrasion resistance. The team used these methodologies to establish requirements against which emerging technologies and glove designs can be assessed at both the component and assembly levels.

The mobility performance testing methodology was an early focus for the HPEG team as it stems from collaborations between the SSA Development team and the JSC Anthropometry and Biomechanics Facility (ABF) that began investigating new methods for suited mobility and fit early in the Constellation Program. The combined HPEG and ABF team used lessons learned from the previous efforts as well as additional reviews of methodologies in physical and occupational therapy arenas to develop a protocol that assesses gloved range of motion, strength, dexterity, tactility, and fit in comparative quantitative terms and also provides qualitative insight to direct hardware design iterations. The protocol was evaluated using five experienced test subjects wearing the EMU pressurized to 4.3psid with three different glove configurations. The results of the testing are presented to illustrate where the protocol is and is not valid for benchmark comparisons. The process for requirements development based upon the results is also presented along with suggested performance values for the High Performance EVA Gloves currently in development.